JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 86, NO. C12, PAGES 12,157–12,158, DECEMBER 20, 1981

Comment on 'Production of Odd Nitrogen in the Stratosphere and Mesosphere: An Intercomparison of Source Strengths' by C. H. Jackman et al.

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The paper by *Jackman et al.* [1980] again reminds me of a problem whose treatment I feel reflects unfavorably on the reputation of atmospheric scientists. As an example, how did a paper whose title included 'An Intercomparison of Source Strengths' and which cited only one independent estimate of such strengths succeed in appearing in the prestigious and peer reviewed *Journal of Geophysical Research*?

Stratospheric models have been producing estimates of the rate of ON (odd nitrogen) production in the stratosphere since 1971, and most atmospheric scientists appear to consider models the most reliable source of such estimates. Yet this source of stratospheric ON production rates was not even mentioned by *Jackman et al.* [1980].

It is not this omission alone which troubles me, but, rather the manner in which model estimates of stratospheric ON production rates and estimates based on observational data have almost always been discussed in isolation and rarely in comparison with each other.

I am not idealogically opposed to numerical models, nor do I believe that observational data infallibly represent the real world. Neither do I seek out unpopular causes just to be different. What I do believe is that the recognition of a contradiction is frequently the first step toward the discovery of new knowledge. Accordingly, I have been completely baffled by the failure of stratospheric scientists in general to consider or even discuss the apparent discrepancy between estimates of stratospheric ON production rates determined from models and from observational data, since this discrepancy was first pointed out by *Ackerman* [1975].

Table 1 cites chronologically the various stratospheric ON production rates that I have been able to find. *Ackerman* [1975] used *Danielsen*'s [1968] replacement times for stratospheric air, available observations of HNO_3 (nitric acid) profiles, and the assumption that return of HNO_3 to the troposphere was the only significant sink for stratospheric ON. Since his lowest estimate was based on filter collections of HNO_3 vapor (thus likely to be an underestimate) and since his other values exceeded most of the model production rates he could find in the literature (first four values of Table 1), he suggested that his analysis implied a source for stratospheric ON in addition to the accepted N_2O (nitrous oxide) source. *Schmeltekopf et al.* [1977] used their N_2O profiles and *Crutzen*'s [1975] two-dimensional model to compute ON production rates and concluded, 'We estimate a global annual production of NO_x of 1600 Kton (N) in the stratosphere, most of which is transported into the troposphere.' They did not explain how ON formed from oxidation of N_2O above the tropopause could then return to the troposphere without affecting the stratospheric budget, and neither did they mention model computed rates for ON production in the stratosphere. *Johnston et al.* [1979] also used the measured N_2O profiles. They cited the larger number of *Schmeltekopf et al.* [1977] and attributed their smaller number to different methods of extrapolating N_2O profiles over Panama and of computing solar intensities. They did cite *Crutzen*'s [1971, 1974] original model estimates of $0.29 - 1.5 \times 10^8/cm^2$ s with the sole comment 'subsequent one-dimensional models have usually fallen within this range.'

Since *Ackerman* [1975], only in *Hudson and Reed* [1979] have I found acknowledgment of the apparent discrepancy between stratospheric ON production rates computed by stratospheric models and those based on observational data, and they dismissed the two fold discrepancy which they found with the comment, 'Given the uncertainties in both models, it is not clear that the discrepancy is significant.'

The model computed rate given by *Hudson and Reed* [1979] was supplied by my colleague D. J. Wuebbles who also calculated the downward flux of nitrogen containing species through the model tropopause. He found that HNO_3 accounted for only 42% of this flux, which implies that *Ackerman*'s [1975] numbers should be multiplied by 2.38.

Changes in stratospheric chemistry since *Hudson and Reed* [1979] seem to imply that model computed rates of stratospheric ON production should have declined again, but I have found no recent model results to check this.

Here is a statistic which provides an annual global integration of the diverse processes of radiation transport, photodecomposition, chemistry, N_2O concentration, and diffusive transport as they interact to determine the mean rate of production of a single key constituent, independent of its partitioning among its various progency. Surely this provides a more meaningful comparison of models and the real world than do comparisons of concentration profiles of individual species. This additional method of verifying theoretical models would appear to be wanted both by stratospheric scientists for pinpointing and correcting specific model weaknesses and by nonspecialists attempting to evaluate the credibility of the models. Yet this particular measure of the validity of stratospheric models appears to have been allowed to fall between the cracks.

This particular disagreement between models and observations has always intrigued me, both because stratospheric scientists seem to have gone out of their way to avoid calling attention to it and because it is so incomprehensible. How can stratospheric models, presumably using the same input data and algorithms, consistently compute lower rates of stratospheric production of ON than have been computed from observational data by *Ackerman* [1975], *Schmeltekopf et al.* [1977], *Johnston et al.* [1979], and now *Jackman et al.* [1980]?

Paper number 1C1287.

TABLE 1. Global Annual Mean Rates for Production of Odd Nitrogen in the Stratosphere Computed by Stratospheric Models and Determined From Observational Data (10^8 molecules/cm^2)

Stratospheric Odd Nitrogen Production Rate: From Models	Stratospheric Odd Nitrogen Production Rate: From Observation	Source
0.5–1.3		*Brasseur and Nicolet* [1973]
0.8–1.0		*Isaksen* [1973]
0.29–1.5		*Crutzen* [1971, 1974]
0.25–0.65		*Wofsy and McElroy* [1974]
0.25–1.5	0.8 to >5.0	*Ackerman* [1975]
	4.5	*Schmeltekopf et al.* [1977]
	2.8	*Johnston et al.* [1979]
2.3	4.5	*Hudson and Reed* [1979]
	2.8	*Jackman et al.* [1980]

Acknowledgment. This work was performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under contract W-7405-Eng-48.

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(Received May 7, 1981;
revised June 29, 1981;
accepted August 12, 1981.)